

REPORT NUMBER: TR-P36135-06-NC
SAFETY COMPLIANCE TESTING FOR FMVSS 301R
FUEL SYSTEM INTEGRITY – REAR IMPACT
79.3 KM/H 70% OVERLAP REAR IMPACT

VOLVO CAR CORPORATION
2016 VOLVO XC90 5-DOOR MPV

NHTSA NUMBER: C20165900

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TEST DATE:
JUNE 15, 2016

REPORT DATE:
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FINAL REPORT

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
ENFORCEMENT
OFFICE OF VEHICLE SAFETY COMPLIANCE
ROOM 6111, NVS-220
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16. Abstract A 79.3 km/h 70% overlap rear impact test was conducted on the subject 2016 Volvo XC90 5-door MPV in accordance with the specifications of the Office of Vehicle Safety Compliance Laboratory Test Procedure for FMVSS 301R. The test was conducted at the KARCO Engineering, LLC. facility in Adelanto, California on June 15, 2016. The impact velocity was 79.29 km/h and the outside ambient temperature was 25 deg. C. There was no Stoddard solvent leakage immediately after the test or during any portion of the static rollover. The test vehicle appeared to comply with all requirements of FMVSS 301R "Fuel System Integrity - Rear Impact".					
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SECTION 1

SUMMARY OF TEST

SUMMARY

The purpose of this rear impact test is to measure the performance of the subject vehicle, a 2016 Volvo XC90 5-door MPV, for FMVSS 301R "Fuel System Integrity – Rear Impact".

This 79.3 km/h 70% Overlap Rear Impact is sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number DTNH22-11-D-00245. It was conducted in accordance with the Office of Vehicle Safety Compliance Laboratory Test Procedure TP-301R-02 for FMVSS 301R "Fuel System Integrity – Rear Impact", dated January, 2007.

The test was performed at KARCO Engineering, LLC. on June 15, 2016. Pre- and post- test photographs of the vehicle and ATD's can be found in Appendix A of this report.

Two (2) real-time cameras and three (3) high-speed cameras were used to document the rear impact event.

Two Part 572E 50th percentile male anthropomorphic test devices (ATD) were placed in the driver and right front passenger seating positions. Both ATD's were not instrumented for this test.

There was no Stoddard solvent leakage after the impact or during any portion of the static rollover. The test vehicle appeared to comply with all requirements of FMVSS 301R "Fuel System Integrity – Rear Impact". FMVSS 301 data is summarized in Data Sheets 4 and 5.

SECTION 2
DATA SHEETS

Test Vehicle: 2016 Volvo XC90 5-Door MPV

NHTSA No.: C20165900

Test Program: 79.3 km/h 70% Overlap Rear Impact

Test Date: 6/15/16

CONVERSION FACTORS

Quantity	Typical Application	Std Units	Metric Unit	Multiply By
Mass	Vehicle Weight	lb	kg	0.4536
Linear Velocity	Impact Velocity	miles/hr	km/hr	1.609344
Length or Distance	Measurements	in	mm	25.4
Volume	Fuel Systems	gal	liter	3.785
Volume	Small Fluids	oz	mL	29.574
Pressure	Tire Pressures	lbf/in ²	kPa	6.895
Temperature	General Use	°F	°C	$=(T_f - 32)/1.8$
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf-ft	N•m	1.355

DATA SHEET NO. 1

TEST VEHICLE SPECIFICATIONS

Test Vehicle: 2016 Volvo XC90 5-Door MPV NHTSA No.: C20165900
 Test Program: 79.3 km/h 70% Overlap Rear Impact Test Date: 6/15/16

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA Number	C20165900
Model Year	2016
Make	Volvo
Model	XC90
Body Style	5-Door MPV
VIN	YV4A22PK2G1031494
Body Color	Magic Blue Meta
Odometer Reading (km / mi)	343 / 213
Engine Displacement (L)	2.0
Type / No. of Cylinders	Inline 4
Engine Placement	Transverse
Transmission Type	Automatic
Transmission Speeds	8
Overdrive	Yes
Final Drive	AWD
Roof Rack	Yes
Sunroof / T-Top	Yes
Running Boards	No
Tilt Steering Wheel	Yes
Power Seats	Yes
Anti-Lock Brakes (ABS)	Yes
Automatic Door Locks (ADLs)	Yes

Traction Control System	Yes
Power Steering	Yes
Power Window Auto-Reverse	Yes
Driver Frontal Airbag	Yes
Driver Curtain Airbag	Yes
Driver Head/Torso Airbag	No
Driver Torso Airbag	No
Driver Torso/Pelvis Airbag	Yes
Driver Pelvis Airbag	No
Driver Knee Airbag	Yes
Front Pass. Frontal Airbag	Yes
Front Pass. Curtain Airbag	Yes
Front Pass. Head/Torso Airbag	No
Front Pass. Torso Airbag	No
Front Pass. Torso/Pelvis Airbag	Yes
Front Pass. Pelvis Airbag	No
Front Pass. Knee Airbag	Yes
Driver Seat Belt Pretensioner	Yes
Driver Load Limiter	Yes
Front Pass. Seat Belt Pretensioner	Yes
Front Pass. Load Limiter	Yes
Other	No

Does Owner's Manual provide instructions to turn off automatic door locks?

Yes

DATA FROM CERTIFICATION LABEL

Manufactured By	Volvo Car Corporation
Date of Manufacture	Sep-15

GVWR (kg)	2749
GAWR Front (kg)	1309
GAWR Rear (kg)	1488

VEHICLE SEATING AND CAPACITY WEIGHT INFORMATION

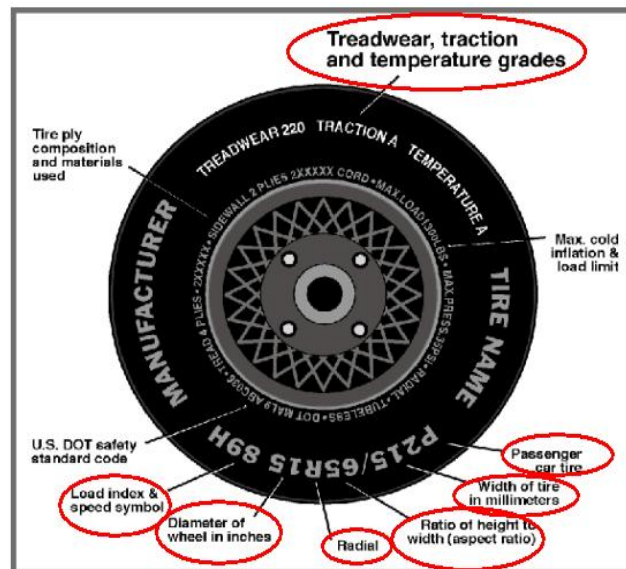
Measured Parameter	Front	Rear	Third	Total	
Type of Seats	Bucket	Bench	Bench		
Designated Seating Capacity	2	3	2	7	
Capacity Weight (VCW) (kg)				550.0	A
DSC x 68 (kg)				476.0	B
Cargo Weight (RCLW) (kg)				74.0	A-B

TEST VEHICLE SPECIFICATIONS

Test Vehicle: 2016 Volvo XC90 5-Door MPV

NHTSA No.: C20165900

Test Program: 79.3 km/h 70% Overlap Rear Impact

Test Date: 6/15/16

VEHICLE TIRE INFORMATION

Measured Parameter	Front	Rear
Max Tire Pressure (kPa)	340	340
Cold Tire Pressure (kPa)	260	260
Max Load Tire Pressure (kPa)		
Recommended Tire Size	P275/45R20	P275/45R20
Tire Size on Vehicle	P275/45R20	P275/45R20
Tire Manufacturer	Pirelli	Pirelli
Tire Model	Scorpion Verde	Scorpion Verde
Load Range	1060	1060
Treadwear Rating	600	600
Traction Rating	A	A
Temperature Grades	A	A
Tire Plies Sidewall	1 Rayon	1 Rayon
Tire Plies Body	2 Rayon, 2 Steel, 1 Polyamide	2 Rayon, 2 Steel, 1 Polyamide
Load Index/Speed Symbol	110V	110V
Tire Material	Rayon, Steel, Polyamide	Rayon, Steel, Polyamide
DOT Safety Code Left	937B P992 3215	937B P992 3215
DOT Safety Code Right	937B P992 3215	937B P992 3215
Type of Spare Tire	T125/80R18	
Location of Tire Placard on Vehicle	Driver B-Pillar	

DATA SHEET NO. 2**PRE-TEST DATA**Test Vehicle: 2016 Volvo XC90 5-Door MPVNHTSA No.: C20165900Test Program: 79.3 km/h 70% Overlap Rear ImpactTest Date: 6/15/16**TEST VEHICLE AXLE WEIGHTS**

	Units	As Delivered (UVW)			As Tested (ATW)			Fully Loaded		
		Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Left	kg	580.5	504.0	1084.5	636.5	557.5	1194.0	613.5	579.5	1193.0
Right	kg	527.0	489.0	1016.0	582.0	540.0	1122.0	563.0	568.0	1131.0
Ratio	%	52.7%	47.3%	100.0%	52.6%	47.4%	100.0%	50.6%	49.4%	100.0%
Total	kg	1107.5	993.0	2100.5	1218.5	1097.5	2316.0	1176.5	1147.5	2324.0

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value	
Total Delivered Weight (UVW)	kg	2100.5	A
Actual Weight of 2 P572 ATDs Used	kg	148.0	B
Rated Cargo/Luggage Wt (RCLW)	kg	74.0	C
Calculated Vehicle Target Wt (TVTW)	kg	2322.5	A+B+C

TEST VEHICLE ATTITUDES

Condition	Units	LF	RF	LR	RR	CG Aft of Front Axle
As Delivered	mm	844	847	847	854	1412
As Tested	mm	834	839	835	841	1415
Fully Loaded	mm	833	837	831	835	1474
Post-Test	mm	830	840	733	733	

GENERAL TEST VEHICLE DATA

Measured Parameter	Units	Value
Total Vehicle Wheel Base	mm	2986
Total Vehicle Length	mm	4972
Total Vehicle Width	mm	1963
Amount of Stoddard Solvent in Fuel Tank	L	66.06

DATA SHEET NO. 2... (CONTINUED)**PRE-TEST DATA**

Test Vehicle: 2016 Volvo XC90 5-Door MPV NHTSA No.: C20165900
Test Program: 79.3 km/h 70% Overlap Rear Impact Test Date: 6/15/16

BALLAST DATA

Description	Value
Type of Ballast	Sand Bottle Dummies
Method of Securing Ballast	Belted into the rear seat
Weight of Ballast	48.0 kg
Weight of Vehicle Components Removed	0.0 kg

VEHICLE COMPONENTS REMOVED TO MEET TEST WEIGHT:

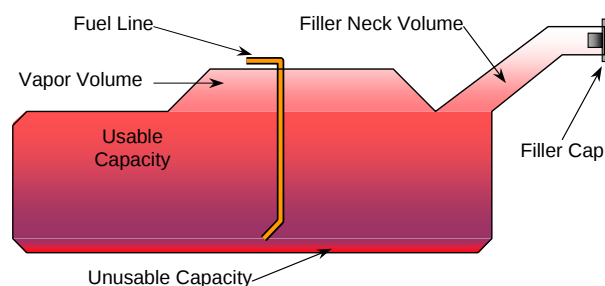
No vehicle components were removed

FUEL TANK CAPACITY

Description	Liters
Fuel System Capacity Listed in Owners Manual	71.01
Usable Capacity of "Standard Tank"	71.01
91 - 94% of Usable Capacity	64.62 - 66.75
Actual Amount of Stoddard Solvent Used	66.06

FUEL PUMP

The vehicle is equipped with an electric fuel pump.
The fuel pump operates when the vehicle is running.



VEHICLE FUEL TANK ASSEMBLY

TEST FLUID

Description	Value
Test Fluid Type	Stoddard Solvent
Test Fluid Specific Gravity	0.76
Test Fluid Kinematic Viscosity	
Test Fluid Color	Purple

DATA SHEET NO. 2... (CONTINUED)

PRE-TEST DATA

Test Vehicle: 2016 Volvo XC90 5-Door MPV

NHTSA No.: C20165900

Test Program: 79.3 km/h 70% Overlap Rear Impact

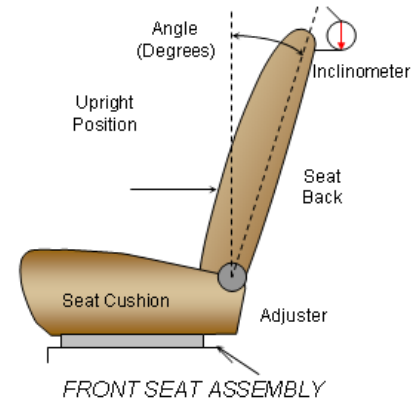
Test Date: 6/15/16

NOMINAL DESIGN RIDING POSITION

Seat back angle is measured using a 600 mm long ruler against the rearmost points of the seat back with a digital inclinometer.

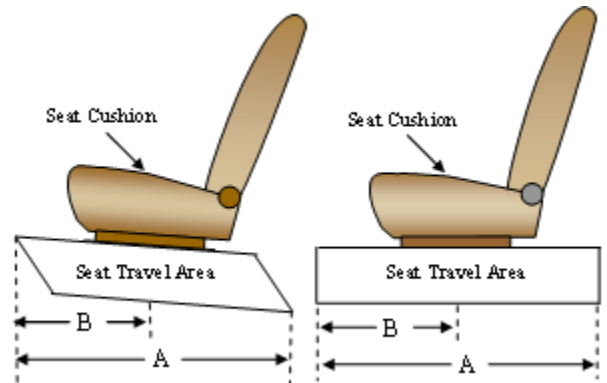
SEAT BACK ANGLE

Seating Position	Degrees
Driver Seat Back Angle	22.5
Passenger Seat Back Angle	22.5



SEAT FORE / AFT POSITIONING

The total seat travel is measured from the forward most possible position to the rear most possible position. The driver's seat is set to the middle of the fore-aft travel. The passenger's seat is set to the middle of the fore-aft travel.



SEAT FORE/AFT POSITIONS

Seating Position	Total Fore-Aft Travel	Placed in Position
Driver Seat	326 mm	163 mm
Passenger Seat	327 mm	164 mm

DATA SHEET NO. 2... (CONTINUED)

PRE-TEST DATA

Test Vehicle: 2016 Volvo XC90 5-Door MPV

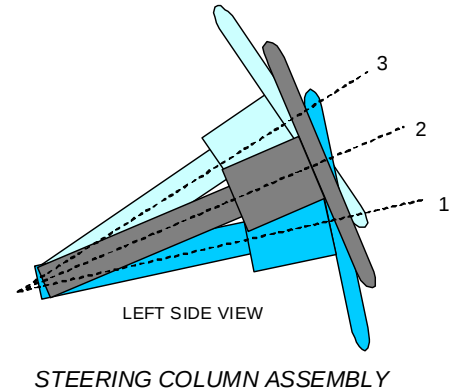
NHTSA No.: C20165900

Test Program: 79.3 km/h 70% Overlap Rear Impact

Test Date: 6/15/16

STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the geometric center of the locus it describes when moved through its full range of motion. A digital inclinometer is used to measure a plate which is placed across the rim of the steering wheel for angular measurements. A tape measure is used to measure telescoping steering wheel travel.



STEERING COLUMN POSITIONING

	Degrees	Fore-Aft Position (mm)
Lowermost Position, No. 1	19.5	97
Geometric Center Position, No. 2	22.6	123
Uppermost Position, No. 3	25.6	148
Telescoping Steering Wheel Travel	6.1	51
Test Position	22.6	123

DATA SHEET NO. 3
MOVING BARRIER DATA

Test Vehicle: 2016 Volvo XC90 5-Door MPV NHTSA No.: C20165900
 Test Program: 79.3 km/h 70% Overlap Rear Impact Test Date: 6/15/16

MOVING BARRIER TEST WEIGHT

	Units	As Delivered Weights (UVW)		
		Front Axle	Rear Axle	Total
Left	kg	377.0	292.5	669.5
Right	kg	389.5	301.5	691.0
Ratio	%	56.3%	43.7%	100.0%
Total	kg	766.5	594.0	1360.5

MOVING BARRIER TIRE INFORMATION

Measured Parameter	Front	Rear
Recommended Tire Size	205/75R15	205/75R15
Tire Size on Vehicle	205/75R15	205/75R15
Tire Manufacturer	Pacemark	Pacemark
Tire Model	All Weather	All Weather
Treadwear	420	420
Traction	A	A
Temperature Grades	B	B
Tire Pressure - Front	220	220
Tire Pressure - Rear	220	220

MOVING BARRIER DIMENSIONS

Measurement Description	Length (mm)
Overall Width	1676
Overall Height	558
Honeycomb Depth	381
Overall Depth	483
Bottom Honeycomb to Bottom Bumper	50
Bumper Height	203
Ground to Top of MDB	788
Ground to Bottom of MDB	228
Ground to Bottom of Bumper	280
Ground to Top of Bumper	483

DATA SHEET NO. 4**POST-TEST DATA**Test Vehicle: 2016 Volvo XC90 5-Door MPV NHTSA No.: C20165900Test Program: 79.3 km/h 70% Overlap Rear Impact Test Date: 6/15/16Temperature at Time of Impact: 25°C Test Time: 11:17 AMVIN: YV4A22PK2G1031494**IMPACT VELOCITY DATA**

Measured Parameter	Units	Value
Trap No. 1 Velocity (Primary)	km/h	79.29
Trap No. 2 Velocity (Redundant)	km/h	79.27

IMPACT POINT LOCATION DATA

Measured Parameter	Units	Tolerance	Value
Vehicle Width	mm		1963
Vertical Impact Reference Line (Left of Vehicle Center Line)	mm		393
Actual Impact Point (Left of Vehicle Center Line)	mm		412
Horizontal Offset (+ right / - left)	mm	± 50 of Intended Impact Point	-19
Vertical Offset (+ down / - up)	mm	± 40 of Intended Impact Point	-7

TARGET VEHICLE STRUCTURAL MEASUREMENTS

No.	Description	Pre-Test	Post-Test	Difference
1	Total Length at Centerline	4972	4910	62
2	Total Length	4972	4860	112
3	Total Width	963	2030	1067
4	Left Side Wheelbase	2986	2990	4
5	Right Side Wheelbase	2986	2933	53

MAXIMUM STATIC CRUSH OF HONEYCOMB FACE

Vertical Location			From Centerline		Max. Crush (mm)
Row	Description	Height (mm)	Distance (mm)	Direction	
A	Center of Bumper	382	800	Left	142
B	Top of Bumper	483	700	Left	270
C	Mid Level	636	0	C/L	340
D	Top of Stack	763	800	Left	339

DATA SHEET NO. 4... (CONTINUED)**POST-TEST DATA**

Test Vehicle: 2016 Volvo XC90 5-Door MPV NHTSA No.: C20165900
Test Program: 79.3 km/h 70% Overlap Rear Impact Test Date: 6/15/16

DOOR OPENING AND SEAT TRACK INFORMATION

Description	Driver	Passenger
Front Door Opening	Remained closed and latched	Remained closed and latched
Rear Door Opening	Remained closed and latched	Remained closed and latched
Hatch and other doors	Rear Hatch Jammed Shut	

FMVSS 301 FUEL SYSTEM INTEGRITY POST-IMPACT DATA**Stoddard Solvent Spillage Measurements**

From impact until vehicle motion ceases: 0 g

(Maximum allowable = 28 g)

For the 5 minute period after motion ceases: 0 g

(Maximum allowable = 28 g)

For the following 25 minutes: 0 g

(Maximum allowable = 28 g/minute)

Spillage: None

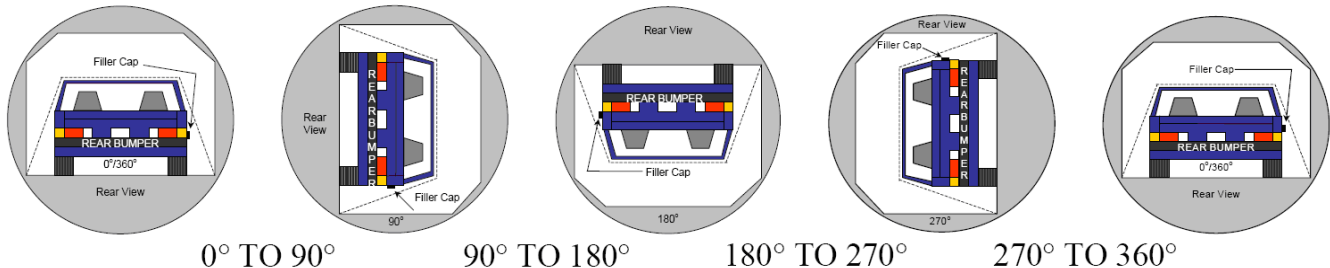
DATA SHEET NO. 5
STATIC ROLLOVER TEST DATA

Test Vehicle: 2016 Volvo XC90 5-Door MPV

NHTSA No.: C20165900

Test Program: 79.3 km/h 70% Overlap Rear Impact

Test Date: 6/15/16



1. The specified fixture rollover rate for each 90° of rotation is 60 to 180 seconds.
2. The position hold time at each position is 300 seconds (minimum).

Details of Stoddard solvent spillage: No Stoddard solvent spillage

SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° To 90°	83	300	383
90° To 180°	83	300	383
180° To 270°	80	300	380
270° To 360°	81	300	381

FMVSS 301 SPILLAGE TABLE

Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eighth Minute
0° To 90°	0 g			
90° To 180°	0 g			
180° To 270°	0 g			
270° To 360°	0 g			

SOLVENT SPILLAGE LOCATION TABLE

Test Phase	Spillage Location
0° To 90°	No Spillage
90° To 180°	No Spillage
180° To 270°	No Spillage
270° To 360°	No Spillage

APPENDIX A
PHOTOGRAPHS

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FIGURE 1. As Received Right Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 2. As Received Left Rear $\frac{3}{4}$ View of Test Vehicle

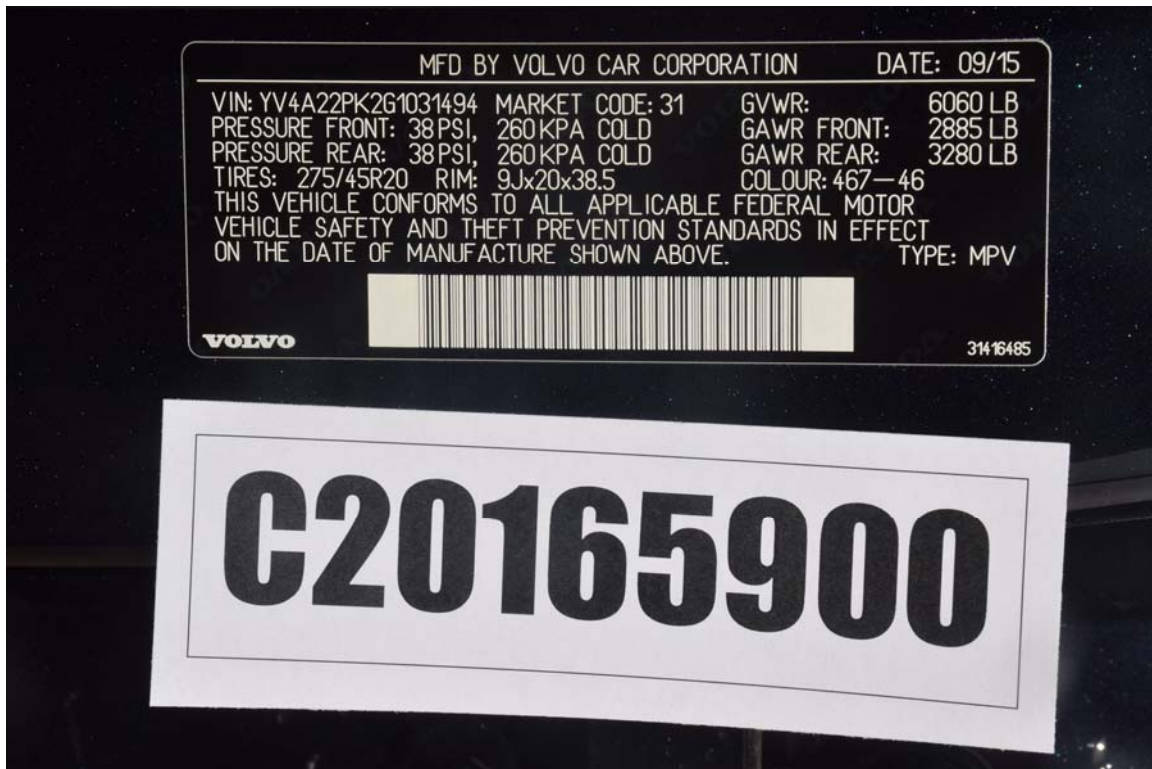


FIGURE 3. Test Vehicle Manufacturer's Label



FIGURE 4. Test Vehicle Tire Information Placard



FIGURE 5. Pre-Test Front View of Test Vehicle



FIGURE 6. Post-Test Front View of Test Vehicle



FIGURE 7. Pre-Test Left Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 8. Post-Test Left Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 9. Pre-Test Left View of Test Vehicle



FIGURE 10. Post-Test Left View of Test Vehicle



FIGURE 11. Pre-Test Left Rear $\frac{3}{4}$ View of Test Vehicle

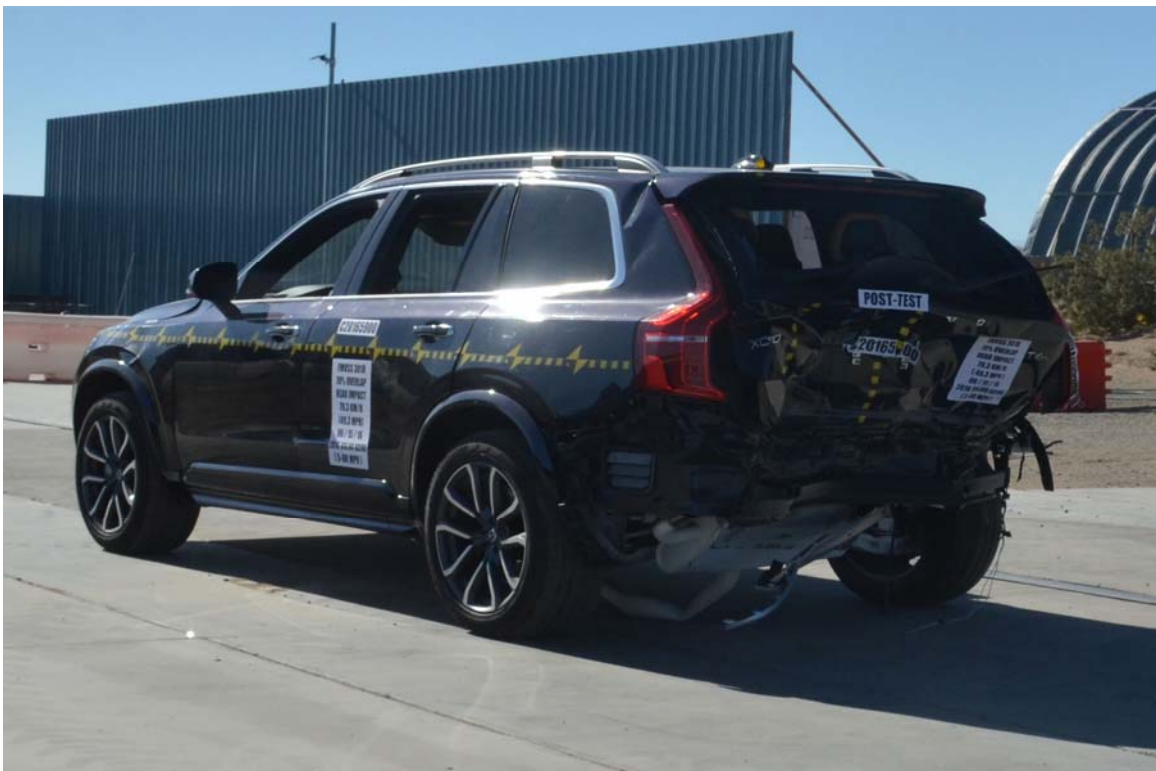


FIGURE 12. Post-Test Left Rear $\frac{3}{4}$ View of Test Vehicle



FIGURE 13. Pre-Test Rear View of Test Vehicle



FIGURE 14. Post-Test Rear View of Test Vehicle



FIGURE 15. Pre-Test Right Rear $\frac{3}{4}$ View of Test Vehicle



FIGURE 16. Post-Test Right Rear $\frac{3}{4}$ View of Test Vehicle



FIGURE 17. Pre-Test Right View of Test Vehicle



FIGURE 18. Post-Test Right View of Test Vehicle



FIGURE 19. Pre-Test Right Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 20. Post-Test Right Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 21. Pre-Test Close-Up View of Impact Point Target



FIGURE 22. Post-Test Close-Up View of Impact Point Target

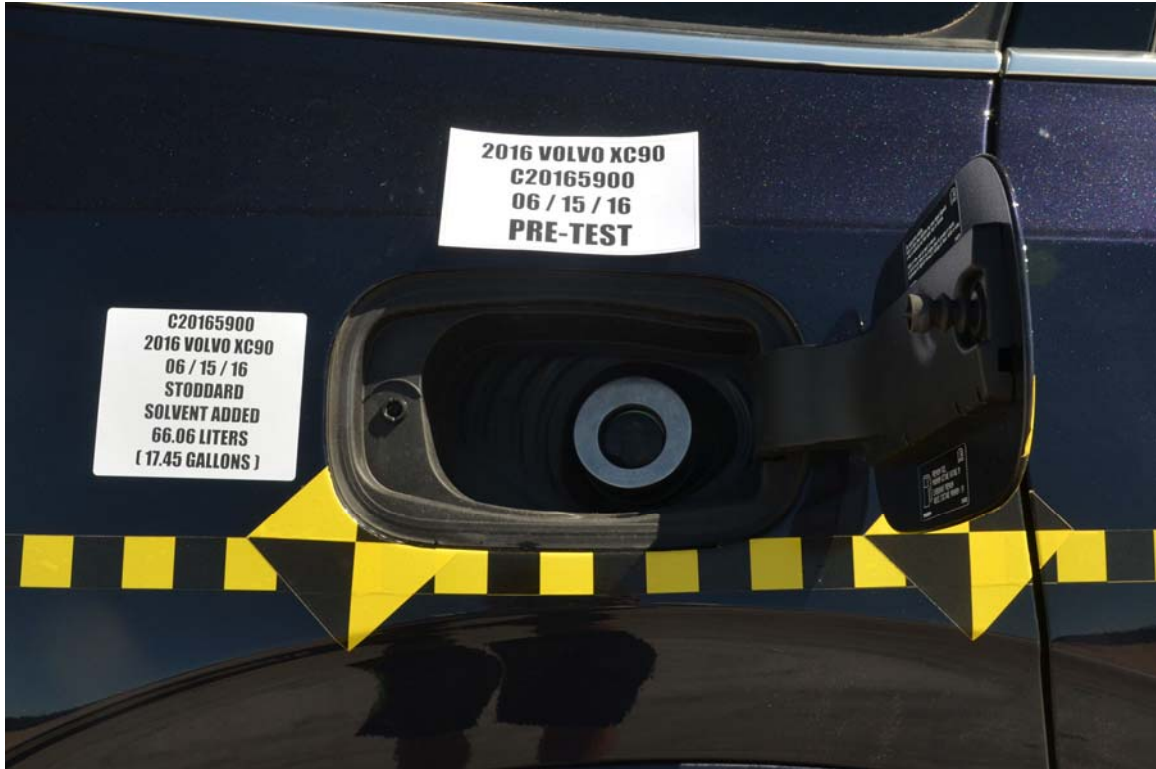


FIGURE 23. Pre-Test View of Fuel Filler Cap



FIGURE 24. Post-Test View of Fuel Filler Cap

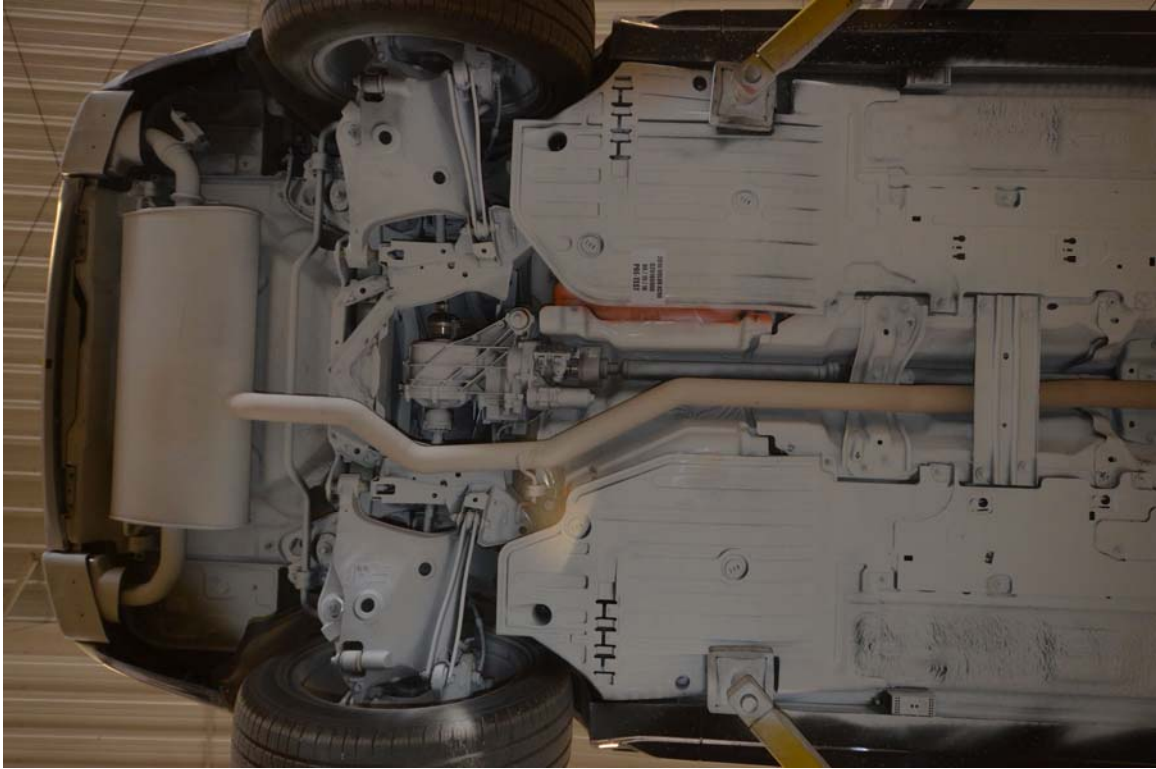


FIGURE 25. Pre-Test Rear Underbody View of Test Vehicle

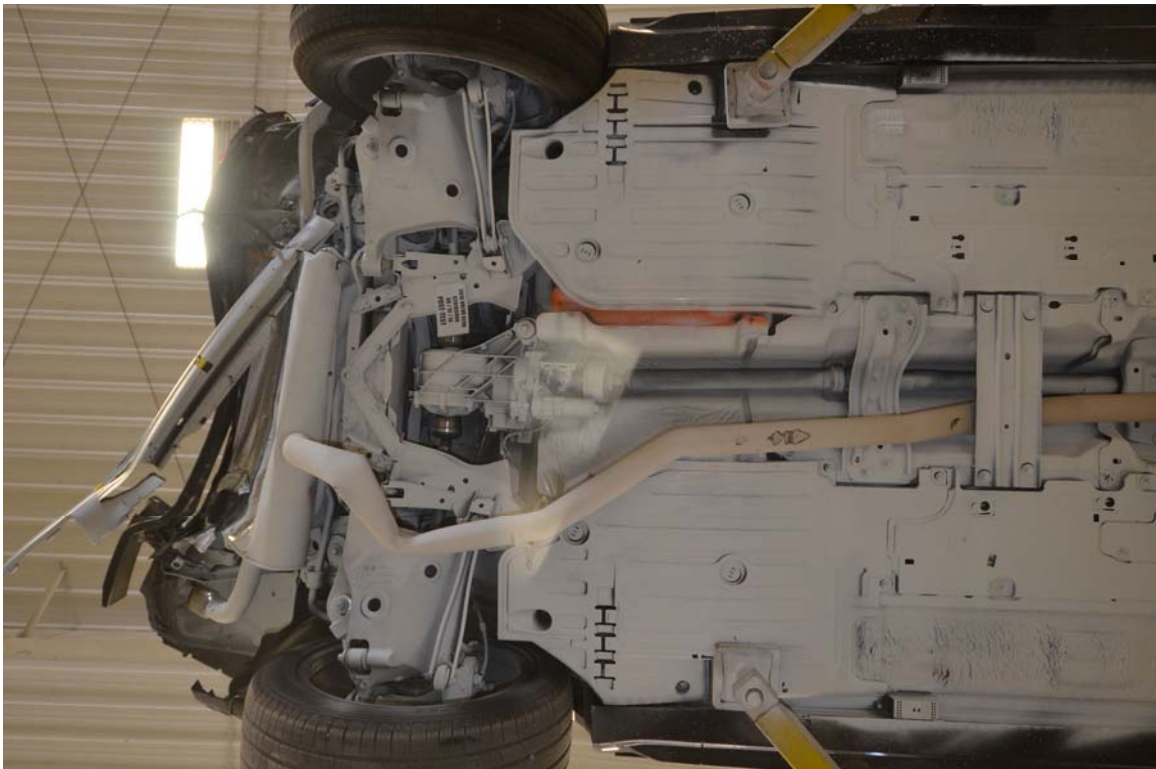


FIGURE 26. Post-Test Rear Underbody View of Test Vehicle



FIGURE 27. Pre-Test Underbody View of Fuel Tank



FIGURE 28. Post-Test Underbody View of Fuel Tank



FIGURE 29. Test Vehicle at 0° on FMVSS 301 Static Rollover Device



FIGURE 30. Test Vehicle at 90° on FMVSS 301 Static Rollover Device



FIGURE 31. Test Vehicle at 180° on FMVSS 301 Static Rollover Device



Test Vehicle at 270° on FMVSS 301 Static Rollover Device



FIGURE 33. Test Vehicle at 360° on FMVSS 301 Static Rollover Device



FIGURE 34. Impact Event